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U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 309.

Experiment Station Work, XLIII.

Compiled from the Publications of the Agricultural Experiment Stations.

ICE FOR HOUSEHOLD USE.

CULTURE AND VARIETIES OF ROOT
CROPS.

COWPEAS AND SOY BEANS.

SILAGE FROM FROSTED CORN.

COOPERATION IN MARKETING CROPS.

INCUBATION OF EGGS.

CAUSES OF DEATH OF YOUNG CHICKS.

SNOW FOR POULTRY.

ERADICATION OF CATTLE TICKS.

BACTERIA IN CREAM.

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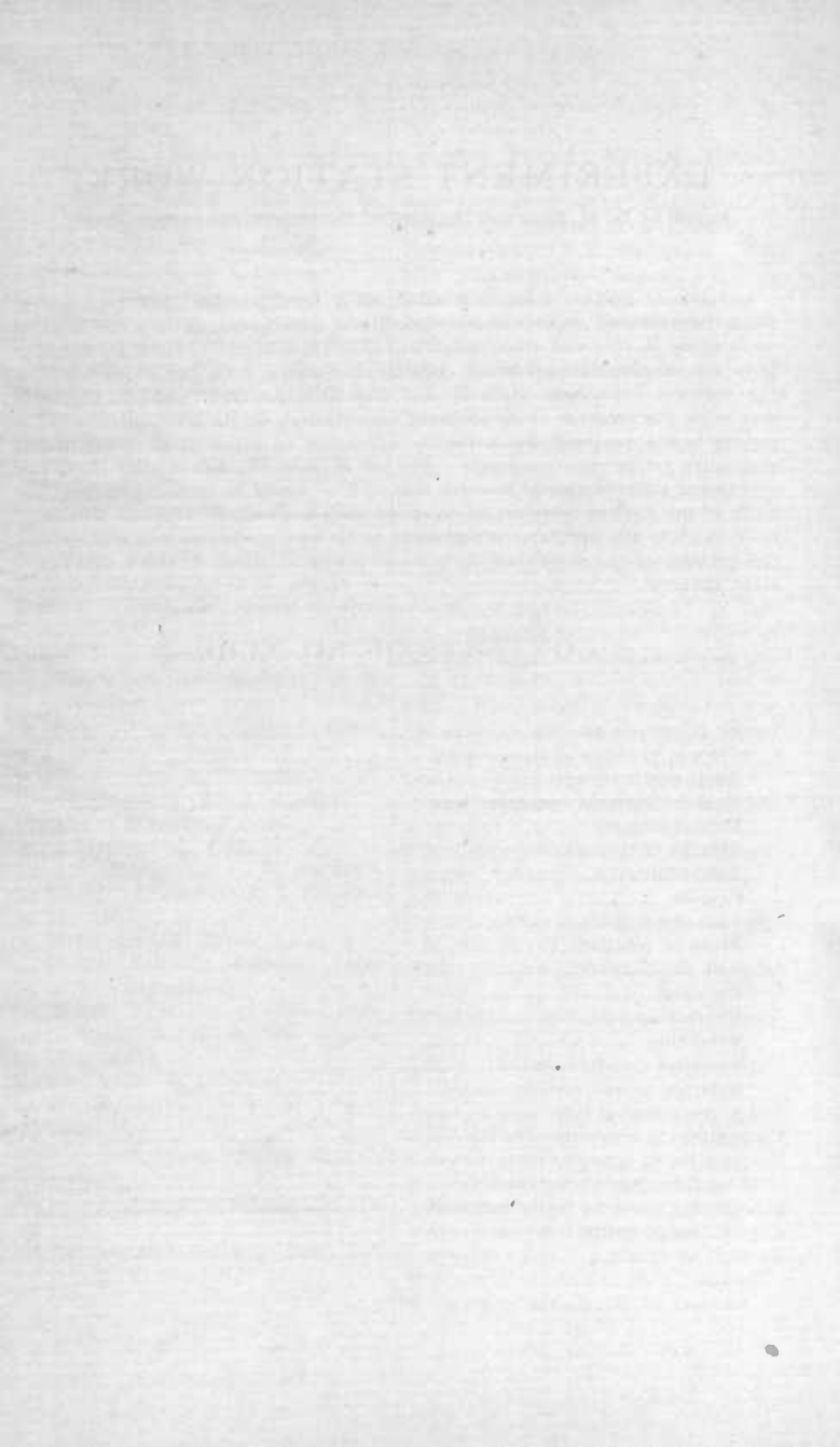
EXPERIMENT STATION WORK.

Edited by W. H. BEAL and the Staff of the Experiment Station Record.

Experiment Station Work is a subseries of brief popular bulletins compiled from the published reports of the agricultural experiment stations and kindred institutions in this and other countries. The chief object of these publications is to disseminate throughout the country information regarding experiments at the different experiment stations, and thus to acquaint farmers in a general way with the progress of agricultural investigation on its practical side. The results herein reported should for the most part be regarded as tentative and suggestive rather than conclusive. Further experiments may modify them, and experience alone can show how far they will be useful in actual practice. The work of the stations must not be depended upon to produce "rules for farming." How to apply the results of experiments to his own conditions will ever remain the problem of the individual farmer.—A. C. TRUE, Director, Office of Experiment Stations.

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EXPERIMENT STATION WORK.^a

ICE FOR HOUSEHOLD USE.^b

The matter of ice and ice supplies has been briefly referred to in a discussion of water for table use in an earlier bulletin of this series.^c

The purity and wholesomeness of the ice supply has heretofore seemed to be a matter of much less concern to both sanitary engineers and consumers than the quality of the water supply. Yet in view of the increasing uses of ice its purity is rapidly becoming a matter of but slightly less importance than that of water. While the chemical composition and the factors which affect the purity of water have received a large amount of attention by the agricultural experiment stations, little study has been made of ice supplies in station laboratories.

The consensus of opinion is that natural ice formed to a reasonable depth is comparatively pure under usual circumstances, but that it is very likely to be contaminated if it freezes to the full depth of a shallow pond or stream, or if it is flooded, particularly with surface water. The Vermont Experiment Station found that of a small number of samples of pond ice examined all were unfit for household use.

The following extracts from a recent publication of the New York State department of health regarding ice and ice supplies bear directly upon this question:

In general there are a great many conceivable ways that ice and ice supplies may become infected. The danger from many of these causes of infection may, however, be so remote or so infrequent as to hardly merit notice. There are, however, a few dangers associated with the formation of natural ice and the harvesting of ice supplies, as now generally practiced, which do merit consideration.

^a A progress record of experimental inquiries, published without assumption of responsibility by the Department for the correctness of the facts and conclusions reported by the stations.

^b Compiled from Vermont Sta. Rpt. 1898, p. 177; Mo. Bul. N. Y. Dept. Health, 23 (1907), No. 2, pp. 2-6.

^c U. S. Dept. Agr., Farmers' Bul. 262, p. 5.

The first of these dangers is the one due to the harvesting of ice from polluted sources. This ice may be taken from ponds or rivers which have been polluted by sewage and may contain the germs of typhoid fever and other diseases.

Secondly, ice may become contaminated during the period and operations of harvesting by filth which may have come from infected sources. The hands and feet of laborers or the hoofs of horses may be the channels by which infection may be transmitted to the ice even after it has been taken from the water, and notwithstanding the purity of the water.

Thirdly, ice may become infected from surface drainage from the adjacent lands during thaws. The water which has thus flowed over infected fields that may have been fertilized or otherwise infected may be carried onto the ice and settle and be frozen into it.

Finally, ice may become infected from the exposure and handling incident to distribution of it in our cities and even within our homes. This may be by far the most serious mode of infection, for it leaves the time interval between infection and transmission too short for any counteracting influence of cold to be exerted.

The opportunities afforded for infection during the distribution of our ice supply are many. They start with the infection by the leemen in handling the ice and include infection from the air of our cities, the dirt and filth gathered while the ice is deposited upon pavements and sometimes in streets, the dirty ice broom, the water with which it is washed, and, finally, the handling just prior to placing in coolers or ice chests. To be sure, these sources may be largely avoided and wholly eliminated by final and careful washing, but here, as in all our daily habits in the preparation of food, sanitary precautions are not always observed, and the dangers may often be more real than apparent.

Notwithstanding the many possibilities of ice infection, examination of the literature of the subject shows that the number of epidemics of disease attributable to ice is small. The reason for the small mortality from ice infection "of which we have authentic record, is due to a series of natural agencies or safeguards * * * which tend, by a process of successive elimination, to reduce or entirely destroy the bacterial or germ life that may have been originally present in the polluted water or have infected the ice after its formation, or even after harvesting."

The first safeguard or influence which is active in the reduction of bacterial life is the well-established phenomenon of subsidence and oxidation upon suspended matters, including bacteria in bodies of quiescent or slowly flowing water. This action, of course, will effect in the greatest degree the purification of ice harvested from ponds and lakes. It affects in a large measure, however, ice collected from rivers and especially those in which the velocities are slow enough to admit of formation of ice of sufficient thickness to warrant harvesting.

The second agent in the self-purification of ice is the removal of suspended and dissolved matters which is brought about during the action of freezing. It is commonly known as the "filtration process of freezing," and it affects not only the suspended matters, such as particles of dirt and bacteria, but also chemicals that are in solution. * * *

Of perhaps the greatest influence in the self-purification of ice is the effect of low temperature upon the vitality and life of the bacteria themselves. It has been found by nearly all observers that bacteria exposed to low temperatures near the freezing point very soon lose their vitality, and if exposed for a sufficient length of time are either killed or become so attenuated as to be

nonpathogenic, i. e., their vitality has been so lowered that they are unable to be sufficiently revived to produce disease.

This effect of low temperature upon the vitality of bacteria is proportional in a measure to the degree of cold, but of much more importance is the effect of the time of exposure. * * * The few that are not killed after exposure for say one month have become so attenuated as to be unable to produce disease.

There is still another influence depending upon time of exposure that must not be confounded with the phenomenon of cold alone. This is the influence or destruction of pathogenic [or disease producing] bacteria when exposed or disseminated through a body of water. It has been found that without special relation to temperature, pathogenic bacteria are slowly killed when discharged into a body of water. This is probably due partially to the fact that water is not a favorable environment to most species of pathogenic bacteria accustomed to environment in a human being, and partially to the fact that when exposed to the ravages of other water bacteria they are soon destroyed. * * *

These facts, while emphasizing the great immunity bestowed by nature, point, however, to the real dangers of ice infection with renewed force. There still remain, for instance, the infection due to handling and distribution; to surface pollution due to the pernicious practice of flooding ice to get a thicker crop; to surface pollution due to rains and melting snow washing pollution from side slopes onto ice that has already formed, and finally to the dangers of artificial ice when this has been manufactured from contaminated water and delivered to consumers before the natural processes of purification have had an opportunity to become active or effective.

It is for the removal of some of these possible or residual dangers, notwithstanding the high efficiency of natural purification, that regulations looking to the conservation of our ice supplies become desirable if not necessary. * * * It needs no proof to show that ice harvested from the vicinity of sewer outlets would be loathsome if not dangerous. In fact, even if there were no danger from such a procedure there would still be an aesthetic objection to organic and other filth associated with polluted waters that make incumbent the forming of laws for the protection of our ice supplies.

With the growth of population and manufacturing industries the pollution of streams, ponds, and lakes is becoming so general as to render it more and more difficult to find unpolluted bodies of water from which to harvest natural ice. It therefore becomes increasingly important to guard against this source of danger to the public health, particularly as the demand for ice is steadily growing and its uses rapidly multiplying.

CULTURE AND VARIETIES OF ROOT CROPS.^a

As explained in an earlier number of this series,^b root crops are a valuable feed for stock, especially during the winter when they supplement the rations of grain and other dry feed stuffs. They thrive best in regions having moist and cool weather, but, nevertheless, enough heat and sunshine to promote rapid growth during the growing season. In many sections of the Northern States root crops may

^a Compiled from New York Cornell Sta. Buls. 243 and 244.

^b U. S. Dept. Agr., Farmers' Bul. 305, p. 19.

be grown with profit, but the fact that their culture is not so generally understood as it should be is probably the reason that they are not grown so extensively in the United States as in Canada and parts of Europe.

The New York Cornell Station has recently published the results of investigations as to the best methods of growing mangels, half-sugar mangels, sugar beets, ruta-bagas, kohl-rabi, hybrid turnips, turnips, and carrots in order that this information might serve as a guide to those wishing to raise any of these crops under similar conditions. The culture of these roots is explained as the experience of the station has determined it, and the leading varieties are described.

SEEDS AND SEEDING.

In discussing seeds and seeding it is pointed out that the commercial "seed" of mangels, half-sugar mangels, sugar beets, and carrots is really the fruit, of which each individual fruit may contain from 1 to 7 seeds. The fruit of the carrot, however, bears only one seed. The commercial seeds of ruta-bagas, turnips, and kohl-rabi are true seeds. Almost all of the seed samples received at the station contained dust, and in some of them the dust and pieces of stem reached 7 per cent of the total weight. The following table gives a comparison of the different kinds of seed studied at the station.

Comparison of root-crop seeds.

Crop.	Seeds per pound.	Germination.
		<i>Per cent.</i>
Mangels.....	32,000 to 185,000	73 to 185
Half-sugar mangels.....	21,000 to 36,000	100 to 136
Sugar beets.....	22,000 to 24,000	102 to 132
Ruta-bagas.....	161,000 to 188,000	83 to 92
Hybrid turnips.....	183,000 to 266,000	71 to 94
Common turnips.....	200,000 to 260,000	89 to 92
Kohl-rabies.....	114,000 to 129,000	48 to 96
Carrots.....	440,000 to 460,000	15 to 83

In the case of carrots, with a germination power of only 15 per cent, the cost of a pound of seed which would grow, based on the ordinary price of the seed, or 60 cents per pound, would be \$4 per pound. This seed was sown at the station, and a good stand was secured, but for each carrot grown over 80 seeds were required. These figures need no comment to show the value and the necessity of good seed.

Sowing from May 6 to 9 proved better at the station for all roots than sowing as late as June 12. Planting early in May generally promotes yield, dry matter content, and keeping quality. On clay loam soil the carrot seed failed to grow when sown one-fourth inch deep, while it grew well in sand sown five-eighths inch deep. Mangels, half-sugar mangels, and sugar beets were all sown three-fourths

inch deep and all others between one-fourth and one-half inch. A distance of 30 inches between rows is advised, in order to admit of horse culture for a longer period of time than when the rows are put nearer together. With this distance between rows the largest yield per acre may not be realized, but by all possible elimination of hand labor roots are produced at the lowest cost per ton.

GENERAL CULTURAL CONSIDERATIONS.

Mangels were ready for thinning thirty to thirty-five days after sowing, ruta-bagas twenty-five to thirty days, turnips sixteen to twenty-five days, and carrots and parsnips about thirty-five to forty days. Clean culture was given and an application of 100 pounds of nitrate of soda per acre was made when the crop was found to be making insufficient growth. Common turnips, some of the hybrid turnips, and cabbages were used from the beginning of September until November, and the other crops were harvested and stored in October and early in November. Cabbages, common turnips, and some of the early hybrid turnips may be used in September, October, and November, the later hybrid turnips and ruta-bagas in November and December, and mangels and half-sugar mangels the rest of the winter. These crops are all well adapted to feeding cattle and sheep, but ruta-bagas are especially good for hogs, and carrots for feeding horses.

A proper rotation, early sowing, and a uniform stand are regarded as essentials for a high yield. Mangels grown continuously on the same land for four years yielded 9.6 tons of roots, containing 1 ton of dry matter, while on land under rotation they yielded 34 tons of roots and 4 tons of dry matter per acre. From 25,000 to 30,000 plants of mangels, ruta-bagas, and hybrid turnips, and from 40,000 to 60,000 plants of carrots per acre are suggested as proper stands.

Two half-sugar mangels, Vilmorin Half-Sugar Rosy and Carter Half-Sugar, are recommended as suitable stock for breeding purposes. Carter Holborn Elephant, Kangaroo, and Garton Superlative ruta-bagas are comparatively free from fibrous roots and have a uniform and good shape. The Yellow Aberdeen hybrid turnip proved best for early fall use, while Garton Pioneer is later and can be stored as well as ruta-bagas. Of the different varieties of turnips for early fall use, Mammoth Improved Green Globe and White Egg are suggested. Carter 100-ton carrot was the best variety for clay loam soil. Lobberich Agricultural carrot did equally well on clay loam and gravel loam, and Giant Wiltshire and Orange Giant gave good yields on heavy clay loam. The two last mentioned varieties, however, were difficult to harvest because they broke off so readily, thus indicating that they are better adapted to deep friable loams. White Vienna and Carter Model kohlrabi gave about equally good yields.

MANGEL-WURZELS.

In a closer consideration of the principal root crops it is pointed out that the five different shapes of mangels grown in this country are the long, half-long, ovoid, tankard, and globe types. In addition to these a long curved type, known as the cow-horn mangel, is grown in Europe. The color of the skin may be white, pink, red, orange, yellow, golden, purple, or black. The flesh, which consists of concentrate rings of firm tissue alternating with rings of softer tissue, is seldom uniform in color. The juice of the softer rings is often colored and may be crimson in the Long Red, golden in the Golden Tankard, or white in the half-sugar mangel and the sugar beet. The long varieties are three to four times as long as their greatest diameter and frequently taper to the crown and the tip of the root. From one-half to two-thirds of the root is below the surface of the ground, which indicates that varieties of this type should be cultivated on deep friable soils worked to a good depth. The half-long varieties are shorter than the long sorts, and they taper from the shoulders to the taproot.

The ovoid form is about two to three times as long as it is broad and tapers to the crown and the tip of the root. The color of the skin is most commonly yellow or orange. About one-half the root may be below ground, and owing to its short length this form is much better fitted for shallow soils than the long forms. The tankard is about two to three times as long as broad and carries its width almost uniformly throughout its entire length. The Golden Tankard, with a deep yellow colored flesh, and the Crimson Tankard, with a crimson or rose colored skin and with crimson rings in the flesh, are perhaps the best known varieties of this form. Four inches in diameter and 10 to 11 inches in length is a common proportion, and generally but 5 inches of the root is below the surface. The globe varieties attain a size of from 4 to 7 inches in diameter and are spherical, or nearly so, in form. This type is particularly well adapted to shallow soils, as frequently from two-thirds to four-fifths of the root forms above ground. The Yellow Globe is the variety most commonly grown.

In order that the descriptions of root crops may be better understood, the different parts are briefly defined. The neck or part that bears the leaves may be long, medium, or short. This part should be as small as possible, as it is of little value for feeding purposes. The shoulders, more prominent in some varieties than in others, consist of the upper part of the stem and do not bear leaves. The shoulders and the neck together constitute the crown, which is removed from sugar beets before using them for the manufacture of sugar. The stem or hypocotyl is the thick fleshy part between the neck and the tapering primary root. It is rich in nutrients and varies in length in different varieties. The primary root appears as a continuation of the stem. It should terminate in a single small taproot, as secondary roots,

prongs, or forks are undesirable, not only increasing the cost of harvesting, but also indicating a coarse and fibrous nature. Well-formed roots are described as smooth, while those lacking the proper shape are referred to as forked or rough. The two depressions running lengthwise down the primary root on opposite sides are known as the dimples. The lateral roots should be fine, fibrous, and fairly abundant, and spring from the dimples. This fibrous root system breaks off in harvesting.

While mangels may be grown on almost all productive soils, deep loams are considered best and are necessary for the production of heavy yields of the long varieties. Mangels and sugar beets need considerable sunshine for the development of the root and the elaboration of sugar. With a good supply of moisture in the soil after the plants have become established they will grow in a warm, dry climate and withstand drought far better than most other crops. In the rotation mangels may be grown between two grain crops or after another intertilled crop which has been heavily manured, as cabbages. Good success is also secured in growing them after clover which has been down for a year, and as they are not harvested until late in the fall, the grain crops best suited to succeed them are oats and corn. If oats follow, the tops should be spread uniformly over the land and plowed under in the fall, because the leaves are a valuable manure, and if left unspread the grain crop will be uneven.

In preparing the soil for mangels it is advised to plow deeply in the fall and to cross-plow or to give a deep disk harrowing in the spring. Ten to 12 tons per acre of barnyard manure should be applied previous to plowing, and this may be supplemented in the spring with fertilizers. The seed bed should be put into fine condition with disk and spike-tooth harrow, and previous to the last two harrowings from 240 to 280 pounds of acid phosphate, 100 to 120 pounds of nitrate of soda, and 100 to 120 pounds of muriate of potash should be mixed together and applied immediately. This treatment will stimulate the young plants into vigorous growth. In some cases 400 to 500 pounds of salt per acre are applied. If the land needs lime, the use of 1,500 to 2,000 pounds per acre will often be found profitable.

Owing to the smallness of the seed it is easy to sow it too deep. From 6 to 8 pounds of good seed are required per acre, and the sowing may be done with a grain drill. A 7-inch 11-hoe drill may be used to sow the seed in either 28 or 35 inch rows. In order to facilitate the use of a 2-horse cultivator the rows should not be less than 30 inches apart. As soon as the plants have four leaves all the plants except little bunches every 6, 8, or 10 inches apart are chopped out with a hoe 5 or 6 inches wide, and after this has been done the remaining plants are thinned to but one plant every 6 to 10 inches. The globes

and tankards require rather a greater width in the row than the long varieties. The bunching and thinning must be done at this stage, for if done later the development of the plants is checked. As soon as the rows can be seen, shallow cultivation is given to keep the land at all times free from weeds and from a hard or crusted surface. If the plants appear stunted when they are thinned, a top dressing of 50 pounds of nitrate of soda per acre mixed with 50 pounds of acid phosphate, or with salt or sand to give it bulk, may be used with profit. The mangels should be harvested before severe frosts occur and may be taken up at any time when the outer leaves have withered. The roots should be pulled up with as little injury as possible and the tops twisted off. If stored in a root cellar, the place should be dry and well ventilated. The average yield is generally from 16 to 29 tons, although at the station during the past three years several varieties have yielded at the rate of 40 tons per acre. The average yield of dry matter per acre during the past three years was between 2.4 and 3 tons. In the case of sugar beets 20 tons of beets contained about 4 to 4.5 tons of dry matter, while the yields of half-sugar mangels ranged between the yields of mangels and sugar beets. The amount of dry matter in mangels usually varies between 7 and 14 per cent. In 1904, on the University farm, the dry matter varied between 9.56 and 16.01 per cent in nine varieties. About half of the dry matter is sugar, the percentage often varying between 3 and 8 per cent. It is pointed out that the average composition of the mangel to-day is practically the same as it was fifty years ago, while the sugar beet has been increased 50 per cent in its value for sugar production during the past forty years.

TURNIPS.

The turnip also consists of a thickened stem and root. The best known types are the common turnip (*Brassica rapa*), the hybrid turnip, and the ruta-baga, Swedish turnip, or Swede (*Brassica campestris* or *Brassica rutabaga*). The common turnip and the ruta-baga are thought by some to be of distinct primary origin, while hybrid turnips are said to be a cross between these two. In the turnip the color of the leaves is a grass green, while the ruta-baga has leaves of bluish green or covered with a bluish white bloom. The turnip finishes its growth in from sixty to ninety days, while the ruta-baga requires from ninety to one hundred and eighty days. The flesh of the turnip is soft, usually white to yellow, more often white, while that of the ruta-baga is firmer, white, yellow, or orange, but more often yellow. Turnip seed is small, only 2 to 3 pounds being sown per acre, while of the larger and darker ruta-baga seed 4 to 5 pounds are required.

Turnips are classified commercially according to their shape, form of the upper part of the root, color of the upper part of the root, and color of the flesh. The principal shapes are long, tankard, round or globe, and flat, but there is considerable variation between these different forms. Some taper toward the tap root, while others are fairly uniform in width. The long type, three or more times as long as broad, generally tapers toward the tap root. The tankard form corresponds to the tankard form of the mangel. A large proportion of the root of this type is above ground and the part underground tapers abruptly toward the tap root. All roots nearly spherical belong to the round or globe form and the flat-shaped turnips are greater in width than in length. The round or globe turnips tend to grow deep in the soil and are better suited to deeper soils than the tankard or flat types. The roots are flat-topped or round-topped, according to the shape of the upper part of the root and the character of the shoulders. The crown should be convex to avoid holding water. The roots are called white, yellow, green, bronze, purple, or red tops, and graystones, according to the color of the part of the root exposed to the light. The roots known as graystones have the upper part mottled with transverse green and purple streaks. The flesh of turnips is generally either white or yellow. The yellow flesh varieties of common turnips are considered of superior quality, and most of the hybrid turnips introduced on account of their superior merit have yellow flesh. The crown should be single; that is, only one shoot or neck should arise from it, as roots with multiple crowns or those having several shoots are generally coarser, more fibrous, and considered of lower feeding value.

The best soils for this crop are free-working lands, rich in organic matter and in good tilth. Common turnips will do better on lighter loams than ruta-bagas, and these will give a better yield than turnips upon heavy to medium loams. Climate is apparently of more importance than soil for this crop. A damp and rather dull climate, with a well-distributed rainfall throughout the growing season, seems to be best. To prepare the land it is recommended that an application of about 10 tons of barnyard manure per acre be plowed under in fall and the land be put in good tilth the next spring. Lime slaked to a very fine powder may be applied at the rate of 1,000 pounds of quicklime per acre and harrowed in with 400 to 600 pounds of acid phosphate and 50 pounds of nitrate of soda. This application must be well incorporated with the soil before sowing and the seed bed made as fine as possible. From $2\frac{1}{2}$ to 5 pounds of seed are usually sown in the case of ruta-bagas and hybrid turnips and from 2 to 4 pounds, or an average of 3 pounds, per acre in the case of common turnips when the rows are 27 to 30 inches apart. It was found at

the station that ruta-bagas and Garton Pioneer hybrid turnips, when sown early, lost in quality by the production of long necks. It is considered best to plant in rows 30 inches apart, which will admit of easy cultivation, and to place the plants 7 to 8 inches apart in the row. With this rate of planting an acre will contain about 28,000 plants. The cultivation consists in keeping the land free from weeds by means of frequent, shallow tillage. As the crop grows quickly, only three or four cultivations can be given, with intervals of seven to ten days, before the leaves meet in the rows. A top dressing of 50 pounds of nitrate of soda is sometimes very advantageous. In 1905 the station secured from 20 to 25 tons per acre from such varieties as the Improved Green Globe and the Carter Mammoth. In 1906 White Egg gave the largest yield. During two years hybrid turnips sown on May 11 yielded at the rate of 23 tons, while those sown June 12 yielded only about 14 tons per acre. Garton Pioneer showed considerable resistance to soft rot, being the only one not attacked, and yielding for the two years at the rate of nearly 28 tons per acre.

The average yield of ruta-bagas from the early sowing for two years was at the rate of 21 tons. The common turnips are harvested as soon as they are large enough and often used for feed in the fall. The hybrid turnips may be used a little later and may even be stored, Garton Pioneer being a good variety for this purpose. Ruta-bagas are usually stored after mangels, but before serious frost has occurred.

KOHL-RABI.

Kohl-rabi (*Brassica caulorapa*) is grown for its thickened stem instead of for its leaves. The crop succeeds wherever ruta-bagas succeed, the cultural treatment of the crop being the same. The crop is not so subject to disease as ruta-bagas, withstands drought better, can be grown on heavier soils, and thrives well on muck land. Its further advantages are that it stands well out of the ground and can be readily pastured by sheep; that it does not seem to cause tainted milk when fed to dairy cows, and that it is also better than the ruta-baga in withstanding frosts and developing in warm climates. Its leaves are as valuable for feed as the stem. Among the well-known varieties are the White and Purple Vienna, Short-top White, Goliath, and Carter Model.

CARROTS.

The carrot, like the mangel and turnip, is made up of thickened stem and root, the proportions of the two parts varying in different varieties. The carrot is composed of a well-defined outer layer, usually red or scarlet in the red varieties, and an inner layer or core, generally yellow or dull white. The outer layer is considered to be of higher feeding value than the pith; hence those containing the

smallest percentage of core should always be selected. This crop requires deep, well-pulverized, sandy loam soil, fitted and cultivated the same as for mangels. The manure should be applied to the previous crop or else be well rotted before being plowed under. The seed germinates very slowly and from 6 to 7 pounds should be sown per acre, although if it is of good germination power 4 or 5 pounds is sufficient. Carrots should be sown in rows about 30 inches apart and the plants left about 3 inches apart in the rows. This gives from 55,000 to 60,000 plants per acre. The crop is usually harvested before severe frost sets in and stored as other roots. At the station the yields varied from 7 to 25 tons per acre, although it is stated that much higher yields are sometimes reported. The leaves of carrots appear to be of higher feeding value than the leaves of mangels or ruta-bagas. Carrots are considered of high value for all classes of stock, but especially of great value for feeding horses.

COWPEAS AND SOY BEANS.^a

The great importance of cowpeas and soy beans to our agriculture is more and more recognized, and the culture of these crops is spreading from year to year, not only in all sections of the Southern States, but even to unexpected northern latitudes. The two crops were recently grown in comparison by the Indiana and Oklahoma experiment stations, and several points worthy of attention were brought out for the benefit of growers. The plants are similar in many respects, while they differ in others, and a comparison of their characteristics leads to a better knowledge of their adaptations and value.

PLACE IN ROTATION.

On most, if not all, farms where cowpeas and soy beans can be grown successfully either one or both can profitably be given a permanent place in the crop rotation. In some localities both crops succeed well, but the one is perhaps better known than the other. For this reason a larger acreage may be devoted to it. In Oklahoma, for instance, where the cowpea is quite extensively grown, the soy bean has not come into such general use as a forage or a grain crop, although it is considered by many a good substitute for the cowpea in the rotation. Both the cowpea and soy bean are well adapted to preceding a crop of wheat. When planted early and well cultivated, it is possible to harvest the crops in August in Oklahoma, leaving ample time to prepare the land for winter wheat.

For the corn and wheat producing sections of the State a three-year rotation, consisting of corn the first, oats the second, and wheat, followed by either cowpeas or soy beans, the third year, is recommended.

^a Compiled from Indiana Sta. Bul. 120; Oklahoma Sta. Bul. 74.

For a more extended rotation the following succession of crops is suggested: Corn, Kafir corn, cotton, oats, and wheat, followed by cowpeas or soy beans the same year. In the sections of the State where broom corn is grown a rotation consisting of broom corn the first year, cowpeas or soy beans the second, and durum wheat the third year, is considered profitable. Many farmers sow cowpeas between the corn rows at the last cultivation, and this practice makes it possible to use the crop twice in a three-year rotation, as, for instance, when oats followed by cowpeas are grown the first year, cotton the second, and corn the third. In addition to increasing the fertility of the soil through their power of using the free nitrogen of the air and storing a considerable quantity of it in their roots, both crops have a beneficial effect upon the physical condition of the soil by making it loose and mellow.

SOIL AND MANURING.

Although cowpeas and soy beans, like other leguminous crops, increase soil fertility, they are not successful on thin and badly worn lands. The influence of barnyard manure on the two crops was shown in an experiment made by the Oklahoma Station. Two crop rotations, one including the cowpea and the other the soy bean, were grown on manured and unmanured ground. In the first corn, oats, wheat, and cowpeas in the order given occupied the soil during a period of three years. Cowpeas were grown in 1902 and 1905, but the latest crop had a poor stand and the yields were low. The plats which had been manured at varying intervals gave an average yield of 3.23 bushels of grain and 0.35 ton of straw per acre, while the unmanured plats yielded 2.88 bushels of grain and 0.29 ton of straw. The second rotation, consisting of castor beans, Kafir corn, cotton, oats, wheat, and soy beans, was completed in five years, necessitating the removal of both wheat and soy beans the last year. The manured plats in this experiment received 14 tons of manure per acre in 1902, but no manurial treatment was given afterwards. In 1904, after the wheat was harvested, the land was disked with a disk harrow several times, and 30 pounds of soy bean seed per acre was put in with a disk drill July 12. This crop required seventy-nine days to mature, and was harvested October 1. The unmanured land produced on an average 11.6 bushels of grain and 0.68 ton of straw and the manured 17.6 bushels of grain and 1.02 tons of straw per acre.

In 1904 cowpeas and soy beans were compared in general farm work on bottom and upland soil. The bottom land was seeded May 5 and the upland June 30. In both trials cowpeas gave much the heavier yields of cured hay per acre. This has also been the experience of the Indiana Station, where the cowpea produced about

twice as much hay and not half as much grain as the soy bean. Heavy rains interfered with the crops on the bottom land, and hence the late planting on the upland soil gave the better results, especially in grain production. The soy bean stood the excessively moist conditions better than the cowpea. Both crops are also quite drought resistant, the power of endurance being a little greater in the soy beans than in the cowpea.

PLANTING.

Both crops are generally drilled in rows 24 to 36 inches apart. At the Indiana Station the common wheat drill was found the most convenient and most satisfactory machine for doing this work. It is recommended that for the medium-sized varieties the drill be set at 2 bushels per acre on the wheat scale, and using the first, fifth, and ninth holes, thus making the drills 32 inches apart for soy beans, or the first, fourth, seventh, and tenth holes, making the drills 24 inches apart for cowpeas. The 32-inch drills require about 23 pounds of seed per acre and the 24-inch drills about 30 pounds. For the smaller seeds the drills should be set at about 2 pecks less and for the larger seeds at about 10 or 12 pecks per acre on the wheat scale. In 1904 at the Oklahoma Station soy beans in rows 24 inches apart gave an average yield of 8.6 bushels of grain and 0.77 ton of straw per acre, while a 32-inch planting produced 10 bushels of seed and 0.89 ton of straw. The average results for three years of experiments in methods of planting soy beans for seed production at the Indiana Station show that drills 32 inches apart and cultivated produced the best yield. Tests at different stations indicate that both crops are sensitive to crowding. In this particular experiment at the Indiana Station 32-inch drills with cultivation gave an average yield of 21.3 bushels per acre, 24-inch drills with cultivation 20.4 bushels, 8-inch drills with no cultivation 15.6 bushels, and broadcasted plats 10.7 bushels.

HARVESTING.

Directions for harvesting given by the Indiana Station state that when the soy bean is desired for hay the crop should be cut when the pods are about half filled and dried and then handled much as peavine hay. It was found, however, that the soy bean is not to be recommended for haymaking, being more distinctively a grain crop, and that the cowpea is much more satisfactory for this purpose. When grown for the grain the soy bean should be harvested as soon as three-fourths of the leaves have fallen and the majority of the pods have attained a brownish color. The crop must not be allowed to ripen too thoroughly, as the pods then have a tendency to burst open and to scatter their seeds. The Medium Green, the Very Dwarf

Brown, and the Ogema soy bean were found to be particularly given to shattering, while the Ito San, Early Brown, and Medium Early Yellow were less liable to loss in this way.

The cowpea should be cut for hay or for soiling when the first pods begin to ripen. This subject is discussed in a previous bulletin of this series.^a

THRESHING.

The Oklahoma Station found that the use of a machine for threshing the cowpeas, even after blank concaves had been put in and some of the teeth of the cylinder removed and the speed of the machine reduced, was not very successful, a large percentage of the grain being broken and spoiled for planting. It is suggested that threshing the seed with a flail will give better results and will cost approximately from 6 to 8 cents per bushel as compared with 4 to 5 cents for machine threshing. The soy bean is not so brittle as the cowpea and can be readily threshed with the machine, provided the precautions above mentioned are taken.

VARIETIES.

With reference to varieties, the Oklahoma Station states that Medium Green, Early White, Ito San, Medium Yellow, and Black soy bean varieties ripen early and mature even in sections where the growing period is much shorter than in Oklahoma. Of the different varieties of soy beans tested at the Indiana Station, the most productive varieties were Medium Green, with an average yield for four years of 22.2 bushels; Early Brown, with 21.5 bushels; Ito San, with 21 bushels, and Medium Early Yellow, with 20.2 bushels per acre. Tests of several varieties of cowpeas made by this station showed that the California Blackeye ranked first in earliness, requiring only one hundred and twelve days to ripen as compared with one hundred and forty-two days for other sorts in the test. The White Era and Whip-poorwill gave the largest yields of grain and the Iron was the best producer of forage. A number of varieties of cowpeas were grown for two years at the Indiana Station, and of these the leading varieties with their average yields of hay per acre annually were as follows: Clay, 7,600 pounds; Iron, 7,400 pounds; Warren, 6,500 pounds, and New Era, 6,450 pounds.

RELATION TO SOIL FERTILITY.

The complaint is sometimes made that the soy bean does not enrich the soil to the same extent as does the culture of the cowpea. Judging from the chemical composition of the two crops it seems possible

^a U. S. Dept. Agr., Farmers' Bul. 222.

that when both crops are removed from the soil the soy bean carries away a greater quantity of fertility because the grain is so much richer in nitrogen than the grain of the cowpea. If, however, both crops are used for green manuring their chemical composition can not produce a wide difference in soil improvement. The higher nitrogen content of the soy bean seed is offset by heavier yields of green material in case of the cowpea.

SILAGE FROM FROSTED CORN.^a

In view of the difference of opinion among farmers as to whether corn is seriously damaged for silage making by frosting, the Vermont Experiment Station undertook experiments in which different sections of the same field of corn were ensiled in unfrosted condition and after different degrees of frosting.

A little more than half of it was cut into the silo on October 7, immature and just barely touched by an extremely light frost. A hard frost seemed imminent that night, but did not occur. Indeed, the first hard frost was delayed two weeks, occurring on the night of October 21. Half of the remainder was cut on that date prior to the frost, mature, ears glazed; the remainder two days later, on Monday, mature, ears glazed, hard frosted or even frozen, with leaves badly whitened.

The feeding value of the different lots of silage was determined by feeding experiments with 21 milch cows for from fifteen to twenty-five weeks. It was found that—

(1) In every case more dry matter was eaten when the mature silage ration was fed, as was to have been expected; (2) the quality of the milk made when the silage from the frozen corn was fed was depressed slightly; (3) the total solid and fat yields were slightly depressed when the ration containing the frozen corn silage was fed; and (4) the products per unit of consumption were depressed when the more mature silages were fed, owing to the greater consumption but smaller production.

The general outcome of the experiments, therefore, was that "the effect of frosting corn, and yet more of freezing it, appears very slightly to have been to depress its feeding value when made into silage."

In view, however, of the fact that from 6 to 15 per cent more total dry matter was harvested as a result of the two weeks' longer growth of the crop, and in view of the presumption that the proportion of digestible dry matter was similarly augmented, a 1 per cent depression resulting from the feeding of frozen silage is a negligible quantity. No ill result on the butter product was observed. It is reported that silage made from frozen corn keeps well in a good silo. It would appear, therefore, that the testimony of this trial is, on the whole, in favor of running frost risks to gain a greater maturation.

^a Compiled from Vermont Sta. Bul. 129, p. 132.

COOPERATION IN MARKETING FRUIT AND TRUCK CROPS.*

The cooperative idea among fruit and truck growers, having passed the experimental stage, has become an important factor in present-day marketing. Scarcely any well-developed horticultural sections are without their associations in one form or other. New fruit and truck regions are being constantly developed, however, and a brief study of cooperative methods may be of value. The benefits to be derived from such organizations are many. Small producers can make combined shipments in car lots, which is now considered the economic unit of shipment. Organizations, through the volume of their business, can secure minimum transportation rates. They can afford to maintain daily telegraphic communications with all of the important markets and are thereby enabled to divert cars already en route to places where the demand is greatest. Growers are advised when to hold and when to ship. Uniform grades and packs are secured. Organizations are in a position to know the actual supply of their respective communities; hence managers, working in harmony, can regulate prices to a considerable extent. Through the association the members can procure packing material, fruit-picking baskets, spraying materials, and pumps, potato bags, etc., at a greatly reduced cost. Successful associations require choice products. By an interchange of ideas and experience members are in position to eliminate unprofitable varieties of fruits or vegetables from the community and to develop thorough and economic systems of cultivation. These and many other advantages might be noted.

Cooperative associations have developed rapidly in the West. Over thirty fruit and produce organizations of various kinds are now doing business in Colorado. In a recent publication of the Colorado Station, W. Paddock describes the workings of these associations, which in a general way are similar to those of other sections.

There are two methods of packing and grading fruit; in one instance the association does all the packing, the growers delivering the fruit to the packing house just as it is taken from the trees. Here the packers, under the direction of a superintendent, sort the fruit into the various grades, and at the same time pack it into boxes or crates. Should there be any culls they are returned to the grower and are at his disposal.

Each grower is given a number, which is used to designate his fruit throughout the season. As each box is packed it is marked with his number and the grade. When the boxes are loaded into the cars the number of boxes, the varieties, and the various grades which belong to any grower are kept account of and duly recorded. In this way the price for each box of fruit in any car is easily determined.

* Compiled from Colorado Sta. Bul. 122; Maryland Sta. Bul. 116; Oregon Sta. Bul. 94. See also Transactions Wisconsin State Hort. Soc. 1907; Canada Dept. Agr., Dairy, and Cold Storage Comr. Bul. 18.

But where there is a very large amount of fruit to be handled it is impossible for the association to do the packing, consequently the growers assume this work. With this arrangement the association employs an inspector, whose duty it is to inspect each load as it is delivered. This he does by opening the boxes on the side in the case of apples, when a good estimate of the contents may be made. If the pack is satisfactory not more than two boxes may be opened. If unsatisfactory, several may be examined, and if all run under the inspector's standard, the entire load must either be placed in a lower grade or else be repacked.

It will be seen that a great deal depends on the inspector, and that it is a difficult position to fill. Upon him depends the reputation of the association, so he must be entirely free to do the work as he sees fit.

Each man's fruit is kept track of by numbers, as in the former case.

The association charges a commission on all sales, usually 5 per cent, to defray expenses. Then, in case the packing is done by the association, an additional charge is made to cover the cost of the box and packing. Any surplus is, of course, distributed as premiums. Any fruit grower may become a member of the association so long as there is stock for sale, and the owner of one share is entitled to all of its privileges. The number of shares one individual may own is limited.

The growers are generally asked and, in many instances, required to furnish an estimate of their crop. In the smaller associations the manager sometimes secures this information by visiting the orchards in person. This estimate is made early in the fall, or not until damage by worms and other causes is practically over and the crop is secure. With this knowledge in hand, the manager can enter into contracts for delivering certain amounts of various varieties or grades.

The system of selling has been radically changed within the past few years. Formerly practically all of the fruit was consigned to commission men, who, as a class, it may be truthfully said, are inclined to do the best they can by their constituents. But too often the experience has been otherwise. Not infrequently has it happened that shipments consigned to a distant city have been reported as not being up to grade, or not in good condition, so the market price could not be realized. In such cases, though the manager may be certain that his fruit is as he represented, he is often unable to help himself, so must take what he can get. But of late years the plan of selling f. o. b. is being practiced more and more, and this is largely due to the organized efforts of the associations. Consignments are only made to well-known firms, and much of this fruit is sold at auction.

But even with this arrangement difficulties arise, so in order to protect themselves the larger associations have an agent at the more important distributing points. It is the duty of the agent, or broker, to inspect all cars which come into his territory, as near the destination as possible, and thus protect the association from dishonest buyers. He also is on hand to adjust the differences which arise when the fruit actually reaches the buyer in poor condition.

Express shipments are only made to comparatively near-by points, and with such shipments the growers receive exactly what the fruit brings, less the expressage and the association's commission. It is usually the early fruits that are expressed, but prohibitive rates prevent any very large amount of business being done in this way.

Such associations often fail in their purpose. The prime causes of failure are well summed up by Waugh,^a on the following page:

^a Fruit harvesting, storing, marketing.

All classes of farmers are constitutionally and proverbially distrustful of other people and of one another. In a fruit association there arise (such is the experience) the most inveterate jealousies. Each man thinks he is furnishing a better grade of fruit than his neighbor, though all share alike in the profits. Each one fears the other will reap some special advantage somehow. In particular, the appointment of managers, superintendents, supervisors of grading, shipping agents, and all other officials of the company offers a sufficient opportunity for the elaboration of all sorts of neighborhood quarrels. Each man thinks he ought to be manager, and when one man is finally chosen he is usually suspected of all sorts of favoritism. In any case, he is apt to be hampered in his business relations by committees, boards of directors, and various kinds of red-tape and foolishness. Often he has to consult a committee before taking any important action. * * *

Another difficulty which arises from the same cause is that subscribers to such an association never want to pay a manager's wages. Two or three dollars a day is considered good pay. Yet such a man is compelled at times to handle thousands of dollars' worth of business. The position is such as in ordinary business life would command a salary of \$5,000 a year or more.

Where such conditions exist there is little chance of success. They may be avoided to a great extent if inexperienced shippers will limit the size of their organization until the minor details connected therewith have been thrashed out. A few selected growers are sufficient to demonstrate to the community the advantages of cooperation, and a healthy expansion will soon take place. When the volume of business is sufficient to warrant such action, the management should be turned over to a man who is especially equipped with a knowledge of the details of marketing, and who has no crop interests of his own. He should receive the confidence of the members and be given a chance to work out his own ideas. The manager's salary should be adequate for the work and responsibility involved. It is sometimes the custom to give him a percentage on the total amount of business transacted. Well-established associations, however, can afford to pay a good manager a straight salary and thus feel more certain of retaining his services from year to year. The Colorado bulletin, previously referred to, contains a report of the Grand Junction Fruit Growers' Association, which "is the oldest and is doing the largest business of any in the State."

This association was started in 1891, when a few growers combined and appointed one of their number salesman of their fruit for the season. This arrangement continued with varying degrees of success up to 1897, when it became apparent that the increased business, if no other cause, would necessitate employing a manager by the year, who should devote his entire time to the association. Accordingly, this was done, and the business has increased year by year, as shown below. That the majority of the stockholders are satisfied with the workings of the association is proven by their loyalty and by the fact that the capital stock has recently been increased to \$100,000 for the purpose of accommodating the increasing number of members.^a

^a Number of stockholders January, 1907, was 666; number of shares of stock sold to January, 1907, was 14,169.

The Grand Junction Fruit Growers' Association—Growth of business.

Year.	Paid growers.	Total business.	Cars shipped.	Year.	Paid growers.	Total business.	Cars shipped.
1897	\$54,065.00	\$88,937.00	167	1902	\$195,975.15	\$287,887.15	618
1898	21,785.00	43,750.00	89	1903	247,188.45	389,305.41	682
1899	21,346.00	56,591.00	82	1904	437,154.33	657,291.11	1,282
1900	68,323.00	114,590.00	202	1905	475,763.00	608,403.30	797
1901	98,972.90	153,880.00	256	1906	555,813.44	814,278.62	1,036

Cooperative associations are especially well developed in the Pacific coast region. According to C. I. Lewis, of the Oregon Station, the Hood River Apple Growers' Union has met with great success.

The Hood River organization now has a membership of over 100 and controls approximately 90 per cent of the fruit of the valley. In four years it has been able to raise the price from 85 cents to \$3.15 for the best grade of Spitzenbergs, and \$2.50 for the best Yellow Newtowns. The prices range somewhat as regards size and quality. As an experiment this past fall the association sent 9 car-loads of fall apples to England. These apples were selling here at approximately 85 cents a box. After all expenses were paid they netted the Hood River growers \$1.32 per box.

As a type of a well organized and managed association in the East, W. N. Hutt, of the Maryland Station, gives the following description of the Peninsula Produce Exchange of the eastern shore of Maryland:

This exchange operates along the lines of the New York, Philadelphia and Norfolk and the Baltimore, Chesapeake and Atlantic railroads. It has 25 local shipping points at each of which is an agent who inspects and brands the grade of produce, and reports to the head office at Olney the amounts and grades of fruit and truck received. The general manager in the head office is in touch by wire with prices in all the large markets, and as soon as the daily reports of receipts and grades are wired in from his local agents is in a position to make his sales and place his consignments where the demand is greatest. The exchange spends over \$10,000 annually in telegrams regarding crops, markets, and prices. The capital stock of the exchange was reported in 1905 at \$31,000. This was owned by the 2,500 farmers who sell through the exchange. In 1905 a dividend of 7 per cent was declared and in 1906 a 10 per cent dividend. In addition to this a surplus was laid by for emergencies. The exchange forwards annually thousands of cars of both sweet and Irish potatoes in addition to other truck and fruit. It is reported as doing an annual business in the neighborhood of \$2,000,000.

Instances of successful organizations might be noted from every prominent horticultural region in the United States. The above examples, however, are sufficient to demonstrate the possibilities of such institutions. The details of organization will vary more or less in their solution, depending greatly on the nature of the region and crops to be handled and the volume of business conducted. In the publications of the Oregon and Colorado stations herein mentioned the text is given of the articles of incorporation and by-laws of certain associations, together with instructions to growers and packers. Such information can usually be procured in printed form from any well-established organization.

EVAPORATION OF EGGS AND OTHER FACTORS WHICH AFFECT INCUBATION.^a

During incubation the egg loses water by evaporation, and the amount lost has an effect upon the number of eggs which hatch. C. A. Whiting, who recently studied this question of evaporation, found that during incubation a fertile egg lost a little over 20 per cent in weight, while a sterile egg receiving like treatment lost 15.5 per cent. Another fertile egg, weighing 2.22 ounces, lost during incubation 21.64 per cent in weight. The chick hatched from the egg weighed 1.55 ounces, or 29.65 per cent less than the egg before incubation. A fertile egg shaken vigorously to destroy the germ lost 17 per cent during incubation.

In tests carried on at the Ontario Agricultural College and Experimental Farm to secure data regarding the evaporation of eggs under different conditions with reference to the number which hatched, it was found that when eggs were hatched by hens in nests in the open, the average evaporation of those which hatched was 10.9 per cent. The same figures were obtained with eggs hatched in a nest lined with rubber cloth and placed inside a building, and a slightly higher value, 11.9 per cent, with nests containing a layer of moist earth and kept inside a building. The highest evaporation of eggs which hatched, 15.15 per cent, was observed with nests containing chaff and kept inside a building. In the case of incubators the average percentage of evaporation of eggs that hatched ranged, under different conditions, from 9.1 to 16.3 per cent. Considering both natural and artificial incubation, the range was from 5.9 to 27 per cent. With outdoor nests 87 per cent of the fertile eggs hatched; with indoor nests containing moist earth, 85 per cent; with indoor nests made of chaff, 77 per cent, and with an indoor nest lined with rubber cloth 100 per cent. In the incubator tests 65 to 76 per cent of the fertile eggs hatched. From the recorded data, W. R. Graham, who conducted the investigations, believes that the best results will be obtained when the evaporation is controlled so that it is about that of eggs hatched by hens with nests out of doors on the ground.

Tests made at the University of St. Louis, by A. C. Eycleshymer, showed that during natural incubation the loss by evaporation was 13 per cent of the original weight of the egg and that this loss could be lessened to 9 per cent and still the egg would give a healthy chick. When increased, experimentally, to 20 per cent, perfect chicks were

^a Compiled from Bnl. South. Cal. Acad. Sci., 5 (1906), No. 3, p. 59; Ann. Rpt. Ontario Agr. Col. and Expt. Farm, 32 (1906), p. 202; Biol. Bul. Mar. Biol. Lab. Woods Hole, 12 (1907), No. 6, p. 360. See also U. S. Dept. Agr., Farmers' Buls. 186, p. 28; 281, p. 24.

also obtained. These results are, in general, much the same as those obtained at the Ontario Experimental Farm, and if average values are considered it seems fair to conclude as did Eycleshymer that in artificial incubation "the moisture in the incubator should be so controlled that it will allow the evaporation of about 13 per cent of the original egg."

In the experiments at St. Louis University the effect of a number of other conditions on the incubation of eggs was also studied.

As regards the turning of eggs, Eycleshymer points out that—

The hen turns the egg in two ways. If a sitting hen be watched as she returns from feeding to sitting, it will be seen that she moves her body rapidly from side to side. Whether the object be to turn the eggs is uncertain. Probably the first object is to bring the surface of the body in the closest possible contact with the growing embryos. Accidentally or purposely, she also turns the eggs. This is not only true of the hen returning from feeding, but also when on the nest, for she is frequently observed moving about and settling down with the same characteristic lateral movements. Sometimes there are so many eggs in the nest or they are so widely scattered that the hen fails to properly cover them. When such conditions occur, the hen invariably uses her beak to bring the outlying eggs in contact with her body. Not only does she frequently thus turn the eggs, but also she very often reaches beneath her body and turns the eggs lying near the center of the nest. Why she does this, is a question which awaits an answer.

H. F. Prince, who studied this question at the Agricultural College of Cornell University,^a with a number of hens, found that in every instance the eggs were moved every day and did not remain in the same part of the nest for more than three days. "The thorough manner in which the hen turns the eggs may well furnish us a clue to the most natural and proper treatment of the eggs when under the artificial conditions of the incubator."

Eycleshymer's experiments with an incubator showed that the best results were obtained when eggs were turned frequently, at least five times. The embryos in unturned eggs not infrequently die, the principal cause of death being attributed to the allantois, a membranous sac essential to the normal development of the embryo, growing fast to the yolk, which causes the rupture of the membrane inclosing the yolk and allows it to escape, so that it can not be taken into the body of the embryo. When the eggs are turned it is probable that the position of the allantois is shifted and thus adhesion to the yolk is prevented. "It should be remarked that during the early days of incubation it is also necessary to turn the eggs frequently; otherwise, the embryo grows fast to the shell membrane."

In a study of the effect of temperature a great many observations were made of the temperature of the eggs directly under the hen, of

^a Cornell Countryman, 3 (1906), p. 139.

the hen's body, and of the eggs during incubation. Special thermometers were used and precautions taken to secure accuracy. Under natural conditions, in the author's opinion, his observations show that the proper temperature of eggs during the first week is about 100° F., 101° F. for the second week, and 102–103° F. for the final week. In the case of artificial incubation the experimental data reported led to the conclusion that the most favorable temperature within the egg chamber is close to 102–103° F., the first half of the incubating period, and 103–104° F. for the latter half.

In any consideration of temperature, the fact must be kept in mind that as the chick grows it gives off more and more heat, so that if an incubator of 200-egg capacity were entirely without artificial heating, the temperature would be much higher than that of the surrounding atmosphere; it consequently follows that less artificial heat is necessary during the later stages of incubation. The 102–103° F. in the earlier stages is largely artificial heat, while the 103–104° F. in the later stages would be the combined animal heat given off by the egg and the artificial heat supplied by the heat radiator.

Under natural conditions eggs are cooled somewhat at intervals during incubation when the hen leaves the nest.

It may be stated with a fair degree of certainty that the cooling of the eggs is due to the necessity of obtaining food, and in no way fundamentally affects the growth of the chick when there is an abundant supply of fresh air. There is not the least doubt, however, but what it has a beneficial influence in cases of poor ventilation, and since no incubator is supplied with too much, it probably is best to adopt the common practice of cooling the eggs. In so doing it would not seem advisable to cool the eggs for more than twenty to thirty minutes each day for the first fifteen or eighteen days.

In natural incubation under usual conditions eggs are well ventilated, as fresh air can always reach them by diffusing through the feathers which cover them and foul air pass off in the same way. As might be supposed, it has been found that the degree of ventilation has a decided effect upon the percentage of eggs which hatch in incubators. In the tests made at the University of St. Louis 85.7 per cent of the fertile eggs hatched in an incubator provided with special ventilation, while only 44.3 per cent hatched in an incubator without ventilation.

When a perfect ventilation has been obtained it has produced certain deleterious effects which must be corrected. It is commonplace to say that when evaporation goes on in still air this air soon becomes saturated and evaporation, if not stopped, goes on very slowly. If, however, the saturated air is constantly removed and dry air takes its place, the rate of evaporation is increased. It is thus evident that any discussion of ventilation must take into consideration the question of moisture.

CAUSES OF DEATH OF YOUNG CHICKS.^a

It has been often noted that a large number of incubator chicks die during the first ten days in the brooder from a looseness of the bowels, which is commonly known among poultry men as white diarrhea. This trouble has been assigned to a variety of causes, among them being irregular temperature, lack of vitality of breeding stock, improper feeding, and poor ventilation not only of brooders but also of the rooms in which the incubators are kept. A committee of Ontario poultry experts after investigating the cause of this mortality among chicks in Ontario and New York concluded that the lack of ventilation was perhaps the most important of the determining factors.^b

The Connecticut Storrs Experiment Station has recently studied this question, being led thereto by the fact that nearly every chick died of 400 hatched in February in different incubators, while large numbers of chicks hatched before and after this date did not exhibit any of the fatal symptoms. Believing that food was an important factor in the problem, C. K. Graham, who carried on the work, fed several lots of chicks with different kinds of feed and noted that the mortality was high in whichever lot received one of the grain mixtures. Careful examination showed that this feed contained a fairly large percentage of musty grain, particularly corn. The young chicks ate all the grains indiscriminately, and their lack of ability to detect wholesome from unwholesome foods was further tested by giving them rations which contained such substances as sawdust, coarse salt, and granulated sugar. These materials were eaten as readily as the grains with which they were mixed. Indeed, "the salt and sugar were always selected first, apparently owing to their bright appearance; but as a rule the chicks did not appear to relish them."

When older chicks hatched by hens, and also those taken from the incubators and given to the hens, were offered these same mixtures, it was exceptional to find a chick that took over a grain or two of salt, sugar, or sawdust.

When musty feed was given to the older incubator chicks it was noticed that those which were eight or nine days old showed considerable discrimination in selecting the grain, while still older chicks refused even larger proportions of the musty kernels.

This forces the conclusion that many of the deaths among young chicks are caused by musty food, although there is no doubt that faulty brooders, chills, overheating, improper ventilation, and lack of vitality in the parent stock should all receive proper credit for their share.

^a Compiled from Conn. Storrs Sta. Bul. 44.

^b Ontario Agr. Col. and Expt. Farms Rpt. 1905, p. 230.

SUBSTITUTING SNOW FOR WATER FOR POULTRY.^a

Unnecessary labor is one of the chief factors which lessens profits in poultry feeding. To provide 500 to 1,000 hens with water, particularly if they are kept in colony houses, requires considerable time, and if the water is warmed and given to the poultry twice a day the labor will be more than doubled. An abundant supply of water is generally conceded to be an essential feature in successful poultry raising; nevertheless cases have been known where a hen had no water for long periods, except that furnished by dew, and still produced a reasonable number of eggs.

The possibility of lessening the labor of caring for poultry by supplying snow instead of water has been studied at the Connecticut Storrs Experiment Station by C. K. Graham. When pullets and hens were fed wheat screenings and beef scrap from hoppers in colony houses on low ground frozen during most of the experimental period and covered with snow during part of the time, the old hens did not furnish as many eggs or appear to be in as good condition as the younger birds.

The old hens were apparently affected by the snow, the egg production being smaller on the days when snow was on the ground and also considerably less when the ground was frozen; that is, on the cold days when water was not accessible. These conditions do not seem to have affected the younger birds, and they show an increase in eggs immediately after each snow storm, gradually dropping back as the snow disappears.

In the case of other lots kept under much the same conditions in houses on higher and drier ground, the cold weather did not affect the egg production materially, "but there was a noticeable increase in the amount of grain eaten during the cold weeks, when comparison is made with the very mild ones. This, however, may have been caused by the birds foraging more during the milder periods. These birds did not appear to mind the cold, and there was not the slightest sign of frosted combs among them, nor were there any colds."

Similar tests were made with a number of other lots and in general it was noted that although there were many variations, on an average the egg yield of poultry supplied with cold water was slightly greater than that of the birds depending upon snow. However, the time saved by using snow and dry meshes amounted to nearly half that ordinarily required for tending the fowls.

Snow was given to young chicks, but the results were disastrous; although chicks that were reared in out-door brooders were let run on the snow crust during bright days when 3 weeks old or over, and no serious results followed.

When warm water was compared with cold water the egg production was somewhat increased, but not enough to pay for the extra labor involved.

^a Compiled from Connecticut Storrs Sta. Bul. 44.

ERADICATION OF CATTLE TICKS.*

The enormous handicap which the presence of Texas fever has placed upon the beef and dairy industries of the Southern States has long been familiar to all who have engaged in these lines of work, as well as to the reading public. The Bureau of Animal Industry made Texas fever one of its important lines of investigation, and solved the problem of the cause of the disease and the means by which it is transmitted. Following upon its preliminary work came the announcement of a satisfactory method for the immunization of northern cattle to Texas fever by the use of the blood of immune southern cattle. This method, first devised by the Bureau of Animal Industry, and later tested on a large scale and perfected in certain details by various experiment stations, has furnished safe means for the introduction of high-grade cattle into the South. This made possible the great improvement of existing beef and dairy cattle in that section of the country.

The ticks, however, still remain. They are recognized as the only means by which the disease may spread from one animal to another, and, in addition to transmitting the disease, they cause other almost equally serious financial losses. Badly infested cattle are kept in poor flesh, and in many instances fail to reach the size which they otherwise would, or fail to mature as early as they normally should. Some animals are killed outright by excessive infestation with ticks. The total annual loss attributable to cattle ticks in the Southern States has been estimated at \$40,000,000. This loss is represented not only by the animals which die of Texas fever and of excessive tick infestation, but by the loss in weight and condition and the depreciation in price of all tick-infested animals, due to the fact that they come from south of the quarantine line. One of the most serious economic results from the presence of cattle ticks in the Southern States is the annoyance, additional expense, and business complications due to the presence of the quarantine line running across the country from ocean to ocean.

For years the idea has been gaining ground that the only satisfactory way to solve the problem of Texas fever is to eradicate the ticks and thus prevent the perpetuation of the disease. A large number of investigators have been engaged in a careful study of the life history of the cattle tick in order to determine whether its extermination is a feasible proposition and the methods by which this result may be most economically brought about. As a result of this investigation three general methods of tick eradication have been perfected,

* Compiled from Georgia Sta. Buls. 49, 64; Louisiana Stas. Buls. 82, 84; South Carolina Sta. Bul. 130; Tennessee Sta. Bul., Vol. XVIII, No. 1; U. S. Dept. Agr., Bur. Anim. Indus. Buls. 1, 78, 97; Circ. 110; U. S. Dept. Agr., Farmers' Buls. 258, 261, and other sources.

any or all of which may be set in operation in a given locality. These methods are direct insecticide treatment of cattle with oils and other substances, rotation of pastures, and starvation of the ticks by the removal of all animals from certain fenced areas.

When the suggestion of tick eradication was first made many of those who were most familiar with the life history and habits of the tick considered it as an impractical proposition. Certain others, however, were more hopeful and began practical tests to determine the efficiency of the method. Without going into details of the organization of these methods it may be stated that the results thus far obtained are so encouraging that even the most skeptical have become convinced of the possibility of final tick eradication. Liberal appropriations have been secured from Congress for the use of the Bureau of Animal Industry in cooperation with State officials in eradicating ticks in the various tick-infested States so that the quarantine line may be gradually pushed farther south. In a conference of Federal and State representatives engaged in this work, held at Nashville, Tenn., on December 5, 1906, the work accomplished during the first five months was presented from a number of standpoints by a number of workers in different sections of the tick-infested States. As stated by Doctor Melvin, the reports received from various inspectors indicate that as a result of five months' work about 50,000 square miles of infested territory had been freed from ticks and might therefore be placed north of the quarantine line. The work is being pushed vigorously in Virginia, North Carolina, Tennessee, Arkansas, Oklahoma, and in other localities within the tick-infested area, and in all localities the methods of starvation, pasture rotation, and direct treatment of cattle with insecticides have yielded the desired results at a comparatively slight expense. In fact, it is at present estimated that the total expense of the complete eradication of the cattle tick from the United States will probably not exceed the amount of annual loss caused to the cattle industry by the presence of the cattle ticks.

A great amount of this work on the part of Federal and State inspectors and veterinary officials must be of an educational nature. It has been found necessary, in the first place, to convince the farmers of the practicability of freeing their farms from ticks and of the desirability of cooperating to the fullest extent in accomplishing these results. The educational propaganda of tick eradication has been carried on largely through farmers' institutes and less formal gatherings of farmers in tick-infested localities and through the personal appeals of inspectors on their tour of inspection from farm to farm. The results of this work are everywhere encouraging, and it seems reasonable to believe that in the future the quarantine line will be gradually pushed southward toward the Gulf.

BACTERIA IN CREAM.^a

In a recent bulletin of the Oklahoma Station, L. L. Lewis and W. R. Wright report that last year many farmers living in the vicinity of the station made butter until the hot days of June, and then gave up the work because they were unable to make a product of good quality. The cream was then delivered to the college creamery, where, with ice at hand, "it was successfully manufactured into a good grade of butter. Most of the butter made on the farms and offered for sale in the local market during the summer months was of such poor quality that it seemed imperative that the experiment station should make investigations along these lines to determine, if possible, the various causes operating to produce such a low-grade product. As the improvement of the butter must be brought about by the improvement of the cream and the conditions under which it is kept, it was decided to determine the condition of the cream as delivered at our creamery," which are considered representative of those of the average creamery in the Territory.

To determine the quality of the cream delivered during the summer months, tests were made beginning with the last of June, 1906, and extending to the first of September of that year. This period included the hottest, and consequently the most unfavorable months for the handling of cream. As a check on these conditions a series of tests was made during the months of December, January, and February following, the coldest season of the year. The reason for selecting the summer and winter seasons for this work was to show by comparison the great influence of a low temperature on the quality of cream.

The results show that cream delivered in summer at an age of 3.3 days contained an average of 462,600,000 bacteria in a cubic centimeter (0.06 cubic inch), while cream delivered in winter at an age of 5 days contained an average of only 134,800,000 bacteria in a cubic centimeter, or less than one-third that of the 3-day-old samples in summer. It thus appears that while age has an influence on the number of bacteria in cream, temperature exercises the greatest control, and that to prevent excessive development of bacteria, cream must be kept cold, and should be delivered frequently at the creamery.

The bacteria were found to increase in cream for a period of three days in summer and four days in winter, after which there was a steady decrease; but it is not to be assumed that old cream is better than fresh cream because it has fewer bacteria, for samples of eight-day cream had an old, unpleasant odor.

As an indication of the care exercised in securing and handling the cream and the milk from which it was obtained, tests were made of the gas-producing and curd-digesting bacteria in the cream delivered. It was found that the combined numbers of gas and digesting germs

^a Compiled from Oklahoma Sta. Bul. 75.

in cream ranged from a fraction of 1 per cent to 2 per cent in summer and from a smaller fraction to a little more than 1 per cent in winter. As gas-producing bacteria are much more troublesome in summer than in winter because a high temperature favors their growth, there is need of greater care in performing dairy operations at that season of the year. Since large numbers of curd-digesting bacteria are found in hay and straw, these feeding materials should not be handled during the milking period.

The ordinary souring of milk is due to the action of lactic bacteria on milk sugar, changing it to lactic acid. Now, since rich cream contains a smaller amount of milk sugar than thin cream, it is evident that the lactic bacteria will produce less acid in the rich than in the thin cream.

Cream becomes more sour with age, though the number of bacteria is less after the third or fourth day, and it was found in these experiments that the average cream more than two days old in summer was too sour to be handled at a creamery with good results.

The results as a whole indicate as essentials of successful butter making in Oklahoma, as elsewhere, (1) clean milk, producing rich cream; (2) cleanly handling of the cream at low temperatures and its prompt conversion into butter.